



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Sato

Serial Number: 09/807,214

Group Art Unit: 1745

Filed: June 1, 2001

Examiner: Julian A. Mercado

Title: ELECTRODE STRUCTURE, ELECTRIC COMPONENTS AND  
MANUFACTURING METHOD

\*\*\*\*\*

DECLARATION BY APPLICANT REGARDING  
OVERLY BROAD RANGE AND  
UNEXPECTED RESULTS

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1453

August 2, 2004

Commissioner:

I, Takaya Sato, being first duly sworn, on oath makes the following statement  
and declaration of facts:

I am a joint inventor of the above-identified patent application (the "subject  
application").

I am employed as chief scientist at Nisshinbo Industries Inc. of Tokyo, Japan  
("Nisshinbo"). I attended Shinshuu University, where I obtained a Masters

degree in Chemistry, and then I obtained my PhD from Kyoto University in 1992. I have been employed with Nisshinbo for the past nineteen years and during my time there I have been involved in significant research, development and testing in the electrochemistry and polymer fields. I have also been involved in the creation and invention of several kinds of products in the polymer and electromechanical device fields, thereby utilizing my technical experience and background. Through my experience I have become well aware of the standards and terminology used in the battery and capacitor industry and have filed patent applications in the polymer science field. Throughout my nineteen years with Nisshinbo I have filed numerous domestic, Japanese patent applications in the same field of art and have had about thirty patents issued in Japan in the same field of art. I have also filed and have had issued ten United States patent applications in the same field of art since the year.

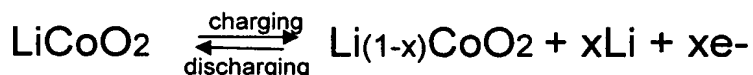
I read the office action issued on serial number 09/807,214 mailed on May 13, 2004 and conducted the experiment of using the ion-conducting polymer which is able to dissolve at least the lithium salts at a concentration of at least 0.1M (mol/l) which shows an electrical conductivity of  $10^{-8}$  S (siemens)/cm at room temperature when dissolved with the lithium salts at a concentration of at least 0.1M.

The advantages of employing this type of polymer coated on the surface of the powdered electrode active material is to shift the critical point at which thermal runaway occurs to a high temperature side. No conventional art, including Hayashi et al., teaches or suggests these limitations. In order to prove the advantages, I provide a declared experiment herewith.

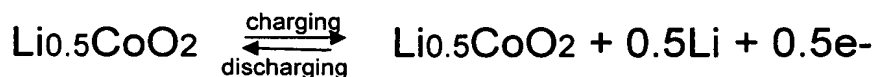
### ***Definition of Overcharging***

Although LiCoO<sub>2</sub> itself is a stable material, it becomes unstable when number of Li atoms in the molecular formula is equal to or less than 0.5, thereby categorized as being in an overcharging state, which is known to explosively generate heat or burn when exposed to a high temperature atmosphere.

- (1) A general equation expressing the reaction on a positive electrode of the lithium ion battery is:



- (2) A following equation expresses the reaction of a fully charged lithium ion battery sold in a today's market:



### ***Experiment A (ion-conducting polymer coating)***

The electrode was prepared according to Example 4 (positive electrode) and Example 6 (negative electrode), and the sample battery was made according to (j) Charging/discharging tests on page 29 of the specification. As the supporting electrolyte salt 1M LiBF<sub>4</sub> in a 1:1 volumetric mixture of ethylenecarbonate and diethylenecarbonate as the nonaqueous solvent was used. The sample battery was fully charged where the active material in the positive electrode was Li<sub>0.5</sub>CoO<sub>2</sub>.

### ***Comparative Example B (polyvinylidene fluoride)***

The electrode was prepared according to Comparative Example 1

(positive electrode) and Comparative Example 2 (negative electrode), and the sample battery was made according to (j) Charging/discharging tests on page 29. As the supporting electrolyte salt 1M LiBF<sub>4</sub> in a 1:1 volumetric mixture of ethylenecarbonate and diethylenecarbonate as the nonaqueous solvent was used. The sample battery was fully charged where the active material in the positive electrode was Li<sub>0.5</sub>CoO<sub>2</sub>.

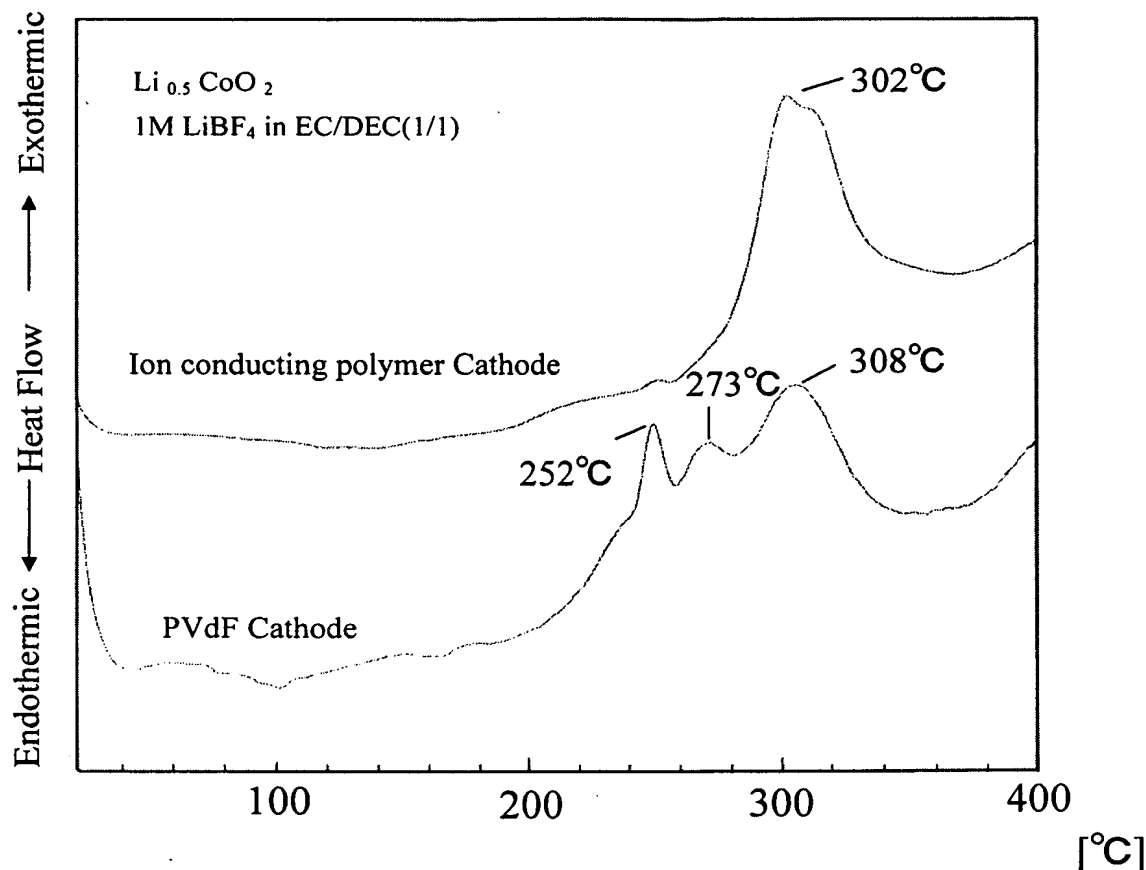
### ***Measuring Method***

The fully charged battery was decomposed under argon atmosphere to extract the positive electrode active material (Li<sub>0.5</sub>CoO<sub>2</sub>). The extracted positive electrode active material was filled in a sealable aluminum test container to perform differential scanning calorimetry (DSC). Temperature was increased at 10°C/min to 400°C. The following graph shows the heat flow measurement which shows some heat peaks after 250°C. These are points at which thermal runaway occurs. This measurement was performed using a differential scanning calorimetry (Seiko Instruments Company Limited).

### ***Results***

The following graph shows the thermal runaway reaction of Comparative Example B using polyvinylidene fluoride (PVdF) at 252°C while the thermal runaway reaction of Experiment A using the ion-conducting polymer coating went up to 302°C. Z. Zhang et al. explains about the experiment of measuring the thermal runaway point with respect to LiCoO<sub>2</sub> (normal state) and Li<sub>0.014</sub>CoO<sub>2</sub> (thermal runaway point). Z. Zhang et al. J. Power Source, 70, 16(1998) which is attached hereto. Z. Zhang et al. using PVdF shows the thermal runaway point approximately equal to Comparative Example B of this

experiment. Accordingly, using the polymer type in the present invention gives significant advantages over conventional arts by offering stability and safety.



I hereby declare that all statements made herein are of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Takaya Sato  
Takaya Sato

August 2, 2004

Chiba, Japan